Amendments to the Claims:

The following listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (currently amended): A photonic device comprising a photonic crystal capable of permitting the propagation or confinement of light through defect states therein, said photonic crystal having configuring means for effecting a local change to the physical geometry in at least one region of said photonic crystal such that the propagation of light therethrough or the confinement of light therein is thereby altered.

2.(original): The photonic device of claim 1, wherein said configuring means includes an electrostrictive component of said photonic crystal.

3.(original): The photonic device of claim 1, wherein said configuring means includes a piezoelectric component of said photonic crystal.

4.(original): The photonic device of claim 1, wherein said configuring means includes a magnetostrictive component of said photonic crystal.

5.(original): The photonic device of claim 1, wherein said configuring means includes an actuation device affixed to said photonic crystal.

6.(original): A photonic device as recited in one of claims 1 to 5, wherein said configuring means provides at least one change in the respective direction of propagation of one or more beams of light of fixed frequency.

7.(original): A photonic device as recited in one of claims 1 to 5, wherein said configuring means provides at least one change in the respective electromagnetic field pattern of one or more modes of confined light.

8.(original): A photonic device as recited in one of claims 1 to 5, wherein said configuring means provides at least one change in the respective frequency of one or more beams of light propagating through said device.

9.(original): A photonic device as recited in one of claims 1 to 5, wherein said configuring means provides at least one change in the respective frequency of one or more modes of light confined in said device.

10. (cancelled)

11.(currently amended): A photonic device as recited in one of claims 1 to 5, ~~wherein photonic device in claim 1,~~ wherein said configuring means provides at least one change in each of the respective direction and frequency of one or more beams of light propagating through said device.

12.(original): A photonic device as recited in one of claims 1 to 5, wherein said configuring means provides at least one change in each of in the respective electromagnetic field pattern and frequency of one or more modes of light confined in said device.

13.(original): A photonic device as recited in one of claims 1 to 5, wherein said configuring means provides at least one change in each of the respective spatio-temporal electric and magnetic field intensities associated with one or more beams of light propagating through said device, or confined therein.

14.(original): A photonic device as recited in one of claims 1 to 5, wherein said configuring means provides one or more changes in the respective direction, frequency,

electric and magnetic field intensity, or combinations thereof, associated with one or more beams of light propagating through said device as a function of time.

15.(original): A photonic device as recited in one of claims 1 to 5, wherein said configuring means provides one or more changes in the respective electromagnetic field pattern, frequency, electric and magnetic field intensity, or combinations thereof, associated with one or more modes of light confined within said device as a function of time.

16.(original): A photonic device as recited in one of claims 1 to 5, wherein said configuring means provides at least one change in the symmetry of one or more modes of light confined in said device, or propagating therethrough.

17. (cancelled)

18.(original): A photonic device as recited in one of claims 1 to 5, wherein said configuring means comprises at least one measured output signal to said device and at least one applied input signal to change the physical geometry of said device, so as to provide for either closed loop control or open loop control.

19.(original): A photonic crystal for use in a photonic device, said photonic crystal <u>having defect states permitting the propagation of light therethrough or the confinement of light therein, and</u> comprising configuring means for effecting a <u>local</u> change to the physical geometry in at least one region of said photonic crystal such that the propagation of light therethrough or the confinement of light therein is thereby altered.

20.(original): The photonic crystal of claim 19, wherein said configuring means includes an electrostrictive component of said photonic crystal.

21.(original): The photonic crystal of claim 19, wherein said configuring means includes a piezoelectric component of said photonic crystal.

22.(original): The photonic crystal of claim 19, wherein said configuring means includes a magnetostrictive component of said photonic crystal.

23.(original): The photonic crystal of claim 19, wherein said configuring means includes an actuation device affixed to said photonic crystal.

24. (new): A photonic device comprising a photonic crystal with at least one element that exhibits a non-linear optical response, having configuring means for effecting a change to the physical geometry in at least one region of said photonic crystal such that the propagation of light therethrough or the confinement of light therein is thereby altered, wherein said configuring means provides at least one change in the non-linear response in said device, for light propagating therethrough or confined therein.

25. (new): A photonic device comprising a photonic crystal having configuring means for effecting a change to the physical geometry in at least one region of said photonic crystal such that the propagation of light therethrough or the confinement of light therein is thereby altered, wherein said configuring means is adaptive for configuration in part or in whole of said device, and includes compensation for imperfections in the photonic crystal structure of said photonic crystal.

26.(new): The photonic device of claims 24 or 25, wherein said configuring means includes an electrostrictive component of said photonic crystal.

27.(new): The photonic device of claims 24 or 25, wherein said configuring means includes a piezoelectric component of said photonic crystal.

28.(new): The photonic device of claims 24 or 25, wherein said configuring means includes a magnetostrictive component of said photonic crystal.

29.(new): The photonic device of claims 24 or 25, wherein said configuring means includes an actuation device affixed to said photonic crystal.

REMARKS/ARGUMENTS

By the present amendment, claims 1, 11 and 19 have been amended. Claims 10 and 17 have been cancelled, and new claims 24 – 29 have been added. Thus, claims 1 – 9, 11 – 16, and 18 – 29 are now pending.

The amendments to the claims have been made without prejudice, and without acquiescing to the examiner's objections. Applicants reserve the right to pursue any of the deleted subject matter in a further continuation, continuation-in-part or divisional application. The amendments do not contain any new matter and their entry is respectfully requested.

The Official Action dated June 10, 2004 has been carefully considered. It is believed that the amended claims submitted herewith and the following comments represent a complete response to the Examiner's rejections and place the present application in condition for allowance. Reconsideration is respectfully requested.

Voluntary Amendment

Claim 11 is hereby amended to delete the words "wherein photonic device in claim 1," which is an apparent drafting error.

Claim Objections

The Examiner has objected to claim 17 on the basis that it contains the limitation "and includes compensation in part or in whole of said device, and includes compensation in part or in whole of the physical geometry of said photonic crystal" in lines 3 – 5. The examiner has helpfully pointed out that the specification indicates that the "compensation" recited is for imperfections in the photonic crystal structure (see page 9, line 31, through page 10, line 1).

Applicants gratefully acknowledge that the examiner has suggested inserting --imperfections in the photonic crystal structure-- after "compensation" in line 3 and inserting --for imperfections-- after "compensation" in line 4. Applicants agree with the former insertion, but respectfully submit that the claim is then made clearer by deleting the words that follow, "in part or in whole of said device, and includes compensation in part or in whole of the physical geometry". The resulting amendment has been submitted in new independent claim 25, which replaces claim 17/1. A similar amendment is also incorporated in new claims 26/25, 27/25, 28/25 and 29/25 which correspond to withdrawn claims 17/2, 17/3, 17/4 and 17/5.

In view of this amendment, applicants respectfully request that the claim objection be withdrawn.

35 USC §112, Second Paragraph

The Examiner has rejected claim 10 pursuant 35 USC §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicants regard as the invention. Specifically, the examiner has pointed out that there is insufficient antecedent basis for the term "the non-linear response" in lines 2 – 3 of the claim.

In response, applicants have withdrawn claim 10 and replaced claim 10/1 with new independent claim 24, which positively recites that the photonic crystal has "at least one element that exhibits a non-linear optical response". As a result, the subsequently recited limitation "the non-linear response" has sufficient antecedent basis. Support for the amendment is found in the specification, particularly page 27, lines 15 – 20. A similar amendment is also incorporated in the claims 26/24, 27/24, 28/24 and 29/24 which correspond to withdrawn claims 10/2, 10/3, 10/4 and 10/5.

In view of the following, we respectfully request that the rejection based on 35 USC §112, second paragraph, be withdrawn.

Allowable Subject Matter

The applicants gratefully acknowledge that the examiner has indicated the subject matter of claims 10 and 17 would be allowable if re-written in independent form, overcoming the claim objection to claim 17, and the rejection of claim 10 under 35 USC §112, second paragraph, noted above. By the present amendment, the applicants have withdrawn claims 10 and 17 and replaced them with new independent claims 24 and 25, respectively. In addition, applicants have added new claims 26 – 29, which correspond to withdrawn claims 10/2, 10/3, 10/4, 10/5, 17/2, 17/3, 17/4, and 17/5, re-written to depend from new claims 24 and 25.

Applicants respectfully submit that new claims 24 – 29 are therefore in condition for allowance.

35 USC §102

The examiner has rejected claims 1, 2, 4, 5, 8/1, 8/2, 8/4, 8/5, 9/1, 9/2, 9/4, 9/5, 13/1, 13/2, 13/4, 13/5, 14/1, 14/2, 14/4, 14/5, 15/1, 15/2, 15/4, 15/5, 19, 20, 22 and 23 under 35 UCS §102(b) as being anticipated by U.S. patent No. 5,385,114 (Milstein et al.).

The applicants respectfully request reconsideration having regard to the amendments to claims 1 and 19 referred to above.

With respect to claims 1 and 19, the examiner has stated that Milstein et al. disclose a photonic crystal having configuring means for effecting a change to the physical geometry in at least one region of the photonic crystal such that the propagation of light therethrough or the confinement of light therein is thereby altered. The examiner has referred particularly to the portion of the Milstein et al. specification starting at column 12, line 60, through column 13, line 45.

The applicants respectfully submit that the photonic crystal disclosed by Milstein et al. is not of the type that is capable of permitting the propagation of light therethrough or the confinement of light therein. Moreover, Milstein et al. does not disclose configuring means for effecting a dimensional change in a specific region such as would alter the propagation or confinement of light.

It is clear to a person skilled in the art that the photonic crystals that are the subject of Milstein et al.'s disclosure do not have any intended defect states. Objectives mentioned by Milstein et al. in column 6 refer merely to the fabrication of a bulk photonic band gap material. The method described by Milstein et al. does not incorporate any steps to include defect states. The example discussed by Milstein et al. starting in column 4, line 53 through column 5, line 65 is that of a crystal exhibiting a full photonic band gap: that is, light is either transmitted by it, or it is reflected.

By distinction, the present invention is concerned with photonic crystals that are capable of permitting the propagation of light therethrough on specific paths, or the confinement of light, by means of defect states within the photonic crystal. This is made clear in the specification, particularly commencing on page 2, line 20 through page 3, line 27.

The specification further describes that the propagation or confinement of light in known photonic crystals having defects states does not permit discretionary switching or re-routing of light signals because the defect states are pre-determined and fixed. The applicants discuss known attempts to configure the propagation or confinement of light in such photonic crystals, for example starting on page 4, line 4, through page 5, line 14. The applicants point out that none of these previous attempts was successful in practical applications because they provided only negligible changes, or they reduced the size of the photonic band gap, or they produced only non-local changes that are not useful for rerouting or confining light in a discretionary fashion.

The examiner has referred particularly to the disclosure in Milstein at al. of the method to control the physical dimensions of Milstein et al.'s photonic band gap material set out in column 12, line 60, through column 13, line 45. It is respectfully submitted that all that is disclosed by Milstein et al. are methods for producing global changes to the crystal. The first of these methods is simply based on adjusting the physical dimensions of the pores and solid elements that make up Milstein et al.'s reticulated photonic band gap material, either by control of the liquid or gaseous infiltration or by control of the deposition. This, of course cannot possibly provide any means for reconfiguring the periodicity of the photonic crystal.

The second method disclosed by Milstein et al. is based on thermal expansion or contraction. While this method could change the periodicity of the photonic crystal, it would do so only on a global basis.

The third method similarly refers to the application of mechanical force or pressure "to modify the dimensions of the pores and solid elements of the photonic band gap material". There is no express teaching of how any such application of mechanical force or pressure could be used to effect anything other than a global change to the entire photonic crystal. Neither would this be inferred since it is clear that Milstein et al. are concerned only with a bulk photonic band gap material, and not a photonic crystal that contains defect states to permit the propagation of light on distinct paths, or the confinement of light, as opposed to merely the transmission or reflection of light.

It is respectfully submitted that original claims 1 and 19 patentably distinguish the applicants' invention from the disclosure of Milstein et al. by reciting "configuring means for effecting a change to the physical geometry in at least one region of said photonic crystal such that the propagation of light therethrough or the confinement of light therein is thereby altered." The photonic crystal disclosed by Milstein et al. has no "configuring means" and no means is disclosed for changing the crystal's physical geometry in any particular "region". The photonic crystal disclosed by Milstein et al. is also not capable of permitting the propagation of light or the confinement of light.

Notwithstanding that applicants consider original claims 1 and 19 patentably distinguish their invention, in an effort to underscore those differences, applicants have now amended claims 1 and 19 as noted above, expressly to recite that the photonic crystal permits the propagation of light or the confinement of light through defect states and that the change of the physical geometry of the crystal is effected locally. Support for these amendments is found throughout the specification, including the passages referred to above, and page 6, line 4 through page 9, line 22, and the drawings.

Regarding claims 2, 4, 5, 20, 22 and 23, the examiner has referred to the mention by Milstein et al. of electrostrictive or magnetostrictive components in column 13, lines 29 – 35. These, however, are clearly distinguishable as being merely approaches to externally caused dimensional changes in the overall photonic crystal, not to cause a local change to a particular region within the crystal.

Similarly, regarding claims 8/1, 8/2, 8/4, 8/5, 9/1, 9/2, 9/4, 9/5, 13/1, 13/2, 13/4, 13/5, 14/1, 14/2, 14/4, 14/5, 15/1, 15/2, 15/4 and 15/5, there is no disclosure in Milstein et al. column 13, lines 14 – 45 or in claim 1 of any means to effect a local change in the physical geometry of one or more regions of a photonic crystal, and there is particularly no disclosure of any such means in a photonic crystal that is capable of permitting the propagation or confinement of light through defect states.

In view of the foregoing, applicants respectfully request that the rejection of claims 1, 19, as amended, and the other claims under 35 UCS §102(b) be withdrawn.

35 UCS §103(a)

The examiner has rejected claims 3, 8/3, 9/3, 13/3, 14/3, 15/3 and 21 under 35 USC §103(a) as being unpatentable over U.S. patent No. 5,385,114 (Milstein et al.). The examiner has argued that Milstein et al. discloses all of the limitations of claims 3 and 21 except for specifically stating that the configuring means includes a piezoelectric

component. The examiner has further argued that it would have been obvious to select a piezoelectric component as the means to apply a mechanical force or pressure to a photonic band gap material, as disclosed by Milstein et al.

As noted above, the photonic crystal disclosed by Milstein et al. is not the type claimed in the present invention inasmuch as it does not include defect states to permit light to be propagated or confined therein. The present invention is further distinguished from the disclosure of Milstein et al. inasmuch as it concerns effecting the change to the physical geometry of the photonic crystal not globally, but confined locally to one or more regions, so as to alter the propagation or confinement of light therein.

As the examiner has mentioned, the disclosure of Milstein et al. suggests "a lack of criticality" in the means used to apply mechanical force and/or pressure. While it may have been obvious to a person skilled in the art to select a piezoelectric component to apply mechanical force and/or pressure externally to cause overall dimensional changes to a photonic crystal, the present applicants are the first to identify the use of a piezoelectric component as a configuring means to effect a local change in the physical geometry of a region of a photonic crystal having defect states that permit the propagation or confinement of light therein so as to thereby alter such propagation or confinement of light.

Applicants therefore respectfully submit that claims 3 and 21 are not obvious from Milstein et al., and further submit that claims 8/3, 9/3, 13/3, 14/3 and 15/3 are also consequently not obvious from Milstein et al.

The examiner has rejected claims 6/1 – 6/5 and 11/1 – 11/5 under 35 UCS §103(a) as being unpatentable over U.S. patent No. 5,385,114 (Milstein et al.) in view of Joannopoulos, "The Almost Magical World of Photonic Crystals". The examiner has argued that Joannopoulos teaches that line defects in photonic crystals act like waveguides and that one of ordinary skill in the art would have found it obvious to use "the configuring means" disclosed by Milstein et al. to create a line-defect in a photonic

crystal device to form a waveguide that would change the direction of propagation of one or more beams of light of fixed frequency."

The applicants reiterate that there is nothing taught or suggested by Milstein et al. to suggest any means for effecting a local change to the physical geometry in a region of a photonic crystal. On the contrary, the disclosure of Milstein et al. is concerned only with effecting global dimensional changes throughout a photonic band gap material. Neither Milstein et al. nor Joannopoulos teach or suggest in any way the use of micro-technology to provide selective spatial modulation of dimensions within a photonic crystal. At most, a combination of the teachings of Milstein et al. and Joannopoulos would suggest the introduction of defects into a photonic crystal structure subjected to bulk-external dimensional changes.

Applicants therefore respectfully request that the rejection of claims 6/1 – 6/5 and 11/1 – 11/5 under 35 UCS §103(a) be withdrawn.

The examiner has rejected claims 7/1 – 7/5, 12/1 – 12/5 and 16/1 – 16/5 under 35 UCS §103(a) as being unpatentable over Milstein et al. in view of U.S. patent 6,711,200 (Scherer et al.)

The examiner has argued that Milstein discloses the limitations of these claims as applied to claims 1-5 above except for stating that the change is in the respective electromagnetic field pattern of one or more modes of confined light. The examiner has further argued that Scherer et al. teach that the mode of confined light depends on the defect geometry of a photonic crystal and it would therefore be obvious to one skilled in the art to change the defect geometry of a photonic crystal in the manner disclosed by Milstein et al. to change the electromagnetic field pattern of one or more modes of confined light.

Applicants respectfully reiterate that the disclosure by Milstein et al. of accomplishing bulk dimensional change to a homogeneous photonic crystal in no way teaches or

suggests the present invention, which is characterized by effecting a local change to the physical geometry within a photonic crystal. Moreover, the structures presented by Scherer et al. are not suitable for modulation of local defect dimensions since they are constrained on a single platform.

Applicants respectfully request, therefore, that the rejection of claims 7/1 – 7/5, 12/1 – 12/5 and 16/1 – 16/5 under 35 UCS §103(a) be withdrawn.

Finally, the examiner has rejected claims 18/1 – 18/5 as being unpatentable over Milstein et al. in view of U.S. patent No. 6,498,886 (Sobiski et al.) The examiner has argued that the additional limitation of claim 18 over claims 1 – 5 of having feedback control is tantamount merely to determining an optimal value of a result effective variable involving only routine skill. The examiner has argued that it would have been obvious to use the feedback control method disclosed by Sobiski et al. to adjust an input signal of an optical device in order to obtain a desired value of an output signal in the device disclosed by Milstein.

Applicants repeat that Milstein et al. do not disclose or suggest a photonic crystal having configuring means to effect a local change to the physical geometry in a confined region so as to alter either the propagation or the confinement of light. Moreover, Sobiski et al. are concerned only with non-photonic crystal structures. The traditional discrete optical systems disclosed by Sobiski et al. are not analogous to the photonic based integral systems of the present invention.

Applicants therefore respectfully request that the rejection of claims 18/1 – 18/5 under 35 UCS §103(a) be withdrawn.